Scientific Literacy Essay

Michael Guye

UIN: 01173134

Diatoms are an incredibly special organism. They are one of the many types of algae however, they contain an extremely unique characteristic that no other organism on planet Earth shares. The cell walls of diatoms are made of silica gel (SiO_2), making the cell walls of these organisms completely clear. Diatoms also serve a crucial role in maintaining our environment. They are responsible for creating 20-30% of the air we breathe. (Spaulding, 2022) Long chains of fatty acids are created and released by them into the surrounding water, giving nutrients to the nearby populations. They are also one of the most diverse protists on Earth, with >20,000 species and a new species being discovered quite often. (Wikipedia, 2022) They also indicate how healthy an aquatic environment is through specific biomarkers they give off. Growing only in specific levels of salt and pH they give researchers a good idea of the relative health of an ecosystem. It is not a stretch to say diatoms are one of the most helpful organisms on Earth.

There is an extremely unique species of Diatoms. It is known as *Phaeodactylum tricornutum* and it is one of the only species of Diatoms that can grow in the absence of Silicon. Due to silicone being the most important part of Diatoms cell wall, this makes this species extremely special in the Bacillariophyceae class. It is also one of three other diatoms to have its entire genome sequenced, containing ~10% prokaryote similar genes (Wikipedia, 2022). This is a considerable number of prokaryotic genes for a eukaryote and could point to some of its interesting quirks. Being a high number of diatoms found in aquatic environments means that it can also be used a bioindicator of that environment's health. This allows us to measure the relative toxic amount of microplastics in certain aquatic ecosystems and how it may affect marine life.

Microplastics are currently being heavily researched on how they negatively affect the environment, and especially the marine environment. Recently an extremely large influx of microplastics has been occurring in the oceans due to the massive amounts of plastic waste generated by facemasks. With the COVID-19 pandemic, facemask usage skyrocketed to amounts never seen before on a global scale. This led to large disposal rate of these masks and improper disposals left them finding their way into marine environments. These facemasks fragmenting in these environments damage the DNA of many marine organisms and negatively affect those ecosystems. They shed off toxic elements such as Manganese, Zinc, and Nickel that organisms are unable to ingest. (Marta Sendra, 2022) (Marta Sendra, 2019) The Diatom *Phaeodactylum tricornutum* has been used in research to see how much toxic plastic waste was found in an aquatic environment. The diatom gives off specific bioindicators of DNA damage such as an increase in oxidative stress, damage to photosynthetic apparatus, and depolarization of the cell membrane.

Phaeodactylum tricornutum was used due to its ease of culturation and reactiveness to microplastics. What was found in the tests of microplastics from facemasks interacting with *Phaeodactylum tricornutum* was that fragmented facemasks presented more toxicity sooner than whole facemasks due to increased degradation.

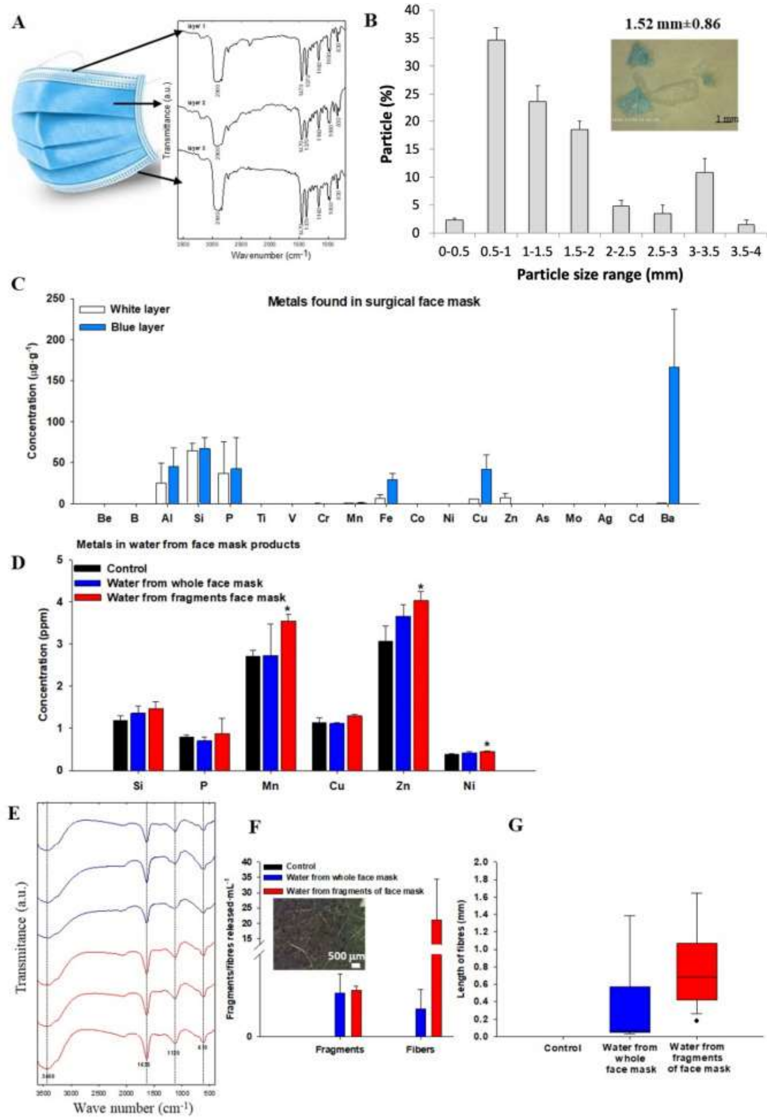
In the experiment where facemasks were ripped up and place in water to track the release of toxic chemicals; there were multiple different methods used to ensure proper shedding and absorption by the water. To properly shred the facemask and avoid contamination from outside sources, a pair of scissors cleaned in ethanol were used to cut the mask into smaller fragments. This method replicated the mask being ripped up. The ripped-up masks were put into acid cleaned flasks containing marine water. (Marta Sendra, 2022) To ensure proper soaking the masks were pushed down with glass stirring rods. Once they had soaked into the water, they endured a constant agitation for 12 hours in light and another 12 out of light to simulate day/night cycles. This cycle continued for approximately one month to allow the masks to full dissociate. Once the water was collected it was time to analyze it to see which metals had been released in that period.

After the one-month period, 15 mL of water from the flask was collected. This sample was then poured through a filter to collect all foreign substances released from the mask. Inductively coupled plasma mass spectrometry (ICP-MS) was used to find the concentration of the metals in the sample. The respective percentages were found to be 109 %, 88 %, 100 %, 90 %, 90 %, 96 %, 100 %, 99 %, and 121 % for V, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb.

The diatom *Phaeodactylum tricornutum* was used to highlight the effects of the metals on a marine environment due to their common use in toxicological tests. (Marta Sendra, 2022) The culture was collected from the ICMAN Marine Microalgae Culture Collection.

The results of the experiment were able to showcase the effects of masks degrading in water very well. Once the metal concentrations were obtained it was found that there was mostly twice as much metal in the water than the controls. There were also some measurements showing that alcohols were released from the masks as well. (Marta Sendra, 2022) In water with fragmented facemasks, there was a significantly higher number of fibers than there was in the water containing full facemasks. When it came to the cytotoxic responses of the algae to either sample the results varied. With the water from the full facemasks the *Phaeodactylum tricornutum* population showed no decrease in cell density compared to the controls. With the algae exposed to the fragmented water, the cell density decreased drastically depending on the concentration of fragmented water it was given. After it was exposed to the water for 48 hours it showed a cell density 7.11 times less dense than the controls. An interesting development noted after 72 hours, however, was a recovery in the population from the chronic exposure. (Marta Sendra, 2022)

In this figure, graphs indicate the behavior of the surgical masks as they went through the 1-month period. Figure A shows the Fourier-transform infrared spectroscopy (FTIR) of the three layers of the masks formed by polypropylene. Figure B indicates the size of the face mask fragments used. Figure C & D show the different metals released into the water and in what amounts they were released. Figure E shows the functional groups released from the facemask in an FTIR graph. Figure F show the total amount of particulates released by the facemasks. Figure G indicates the length of the fibers from the masks after 1 month. (Marta Sendra, 2022)



Works Cited

Gunasekaran, K., 2022. Personal protective equipment (PPE) pollution driven by the COVID-19 pandemic in coastal environment, Southeast Coast of India. *Marine Pollution Bulletin,* Volume 180.

Marta Sendra, A. R.-R. M. P. Y. J. B. A. T.-S., 2022. Products released from surgical face masks can provoke cytotoxicity in the marine diatom Phaeodactylum tricornutum. *Science of the total environment,* 841(156611), p. 1.

Marta Sendra, E. S. M. P. Y. I. M.-G. J. M. G. I. C. J. B., 2019. Are the primary characteristics of polystyrene nanoplastics responsible for toxicity and ad/absorption in the marine diatom Phaeodactylum tricornutum?. *Environmental Pollution,* Volume 249, pp. 610-619.

Spaulding, S. A., 2022. What are Diatoms?. *Diatom Research,* 36(4), pp. 291-304.

Wikipedia, 2022. *Phaeodactylum tricornutum,* s.l.: s.n.